Remarks/Arguments

Reconsideration of the rejections of claims 21, 2, 3, 7-13, 19 and 20 under 35 USC102 based on DE2643769 and of claim 6 under 35 USC103 based on DE2643769 is respectfully requested for the following reasons.

Applicants enclose a complete translation of DE2643769, which the Examiner may find helpful. Although the device disclosed in DE 2643769, hereinafter referred to as the HDW device, is superficially similar to that of the present invention, in fact there are significant differences in purpose, structure and operation. The present invention provides a seal for use in abrasive environments such as mineral extraction, tunnel boring or dredging. It is characteristic of such environments that the outside of the seal is continuously assaulted by abrasive particles. In prior art devices these collect around the seal lip end and due to the relative movement of the shaft and the seal may become entrained between the lip and the shaft. The seal then suffers accelerated wear.

The present invention solves this problem by providing a shield over the greater part of the exposed face of the sealing lip. The extreme end of the sealing lip is not covered

(otherwise the end of the shield would contact the shaft and become damaged by the abrasive particles). Instead the end of the sealing lip is protected by grease or other fluid being extruded down the passage define between the shield and the sealing lip and hence over the lip end. Any abrasive particles at or near the lip are entrained by the fluid and removed.

The HDW seal is for specific application to stern tubes of ships. Here the aggressive environment to be excluded is sea water, which generally does not contain abrasive particles (or if it does they are washed off the seal by the perpetual movement of the sea water) but has no lubricating qualities. In the HDW seal disclosed in DE2643769, all of the elements are sealing lips. The outermost one is protected from wear by having water passed through the chamber 14 in sufficient quantity to lift the seal from the shaft. The next seal can also be lifted from the shaft by a jet-pump effect. None of these seals have any shielding function towards another seal. Indeed because the sea water does not cause abrasive particles accrete around the seal, there is nothing for the seal to be shielded from.

Neither do any of the seals contact each other, contrary to the Examiner's assertion. They are specifically

said to contact the shaft surface. The left-handed seal in fact defines the operative part of its nozzle with the shaft surface, and not with the adjacent seal. Thus in HDW the ends of adjacent seals are not "closed together" as called for in the claims of the instant application; this phrase means (and can only mean) that they are in contact. In particular the Examiner's interpretation of Fig. 1 of DE2643769 is wrong. Also enclosed is an enlarged view in which applicants have shaded the two seals; it clearly can be seen that the seals do not touch, and that the ring nozzle 14 extends radially inwardly all the way to the shaft. (The line across the bottom of the nozzle is a drawing error).

Seals for abrasive environments and seal for stern tubes are two specialized and distinct arts. One skilled in the art looking for a solution to an abrasive environment sealing problem would not look amongst stern tube seals, for the reasons given above. But even if he did, and came upon the HDW specification (DE2643769) he would dismiss it as irrelevant. The outermost seal of HDW is exposed to the environment. If that environment were abrasive the seal would quickly be destroyed, and then the next seal would in turn be attacked by

the abrasive particles. Thus even in a cascaded seal, the sealing lips would be successively destroyed.

Even if one skilled in the art were to start from the HDW seal he would have to make fundamental design changes which go far beyond non-inventive modification to arrive at the present invention. Firstly, he would have to recognize the need to protect the seals from abrasive particles. This would involve sacrificing the sealing function of the outermost sealing lip, and turning it into a shield. Secondly he would have to shorten the newly-converted shield and re-arrange it to bear on the next sealing lip while leaving the lip end of that sealing lip exposed. Both of these steps are counter-intuitive; it would appear to the skilled artisan that he is reducing the sealing integrity of the overall structure rather than increasing it. He thus would dismiss any such suggestion as unworkable and having no prospect of success.

In view of the foregoing, claims 21, 2, 3, 6-13, 19 and 20 as amended are believed to patentably distinguish over DE2643769 within the meaning of 35 USC102 and 35 USC103.

Favorable action on this application is respectfully requested.

Respectfully submitted,

Hodgson Russ LLP

By 
Martin G. Linihan, Reg. No. 24,926

One M&T Plaza, Suite 2000
Buffalo, New York 14203-2391
Tel:(716) 848-1367
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APPLICATION 26 43 769

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Date of application : 28.9.76
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Union priority:

Title: Seal for rotating shafts

Applicant: Howaldtswerke-Deutsche Werft AG Hamburg und Kiel, 2300 Kiel

Inventor: Mewes, Günter, 2103 Hamburg

Examination in accordance § 28 b PatG is requested.

Patent claims

1. Seal for rotating shafts, in particular stern tube seal for marine screw propeller bearings, a pressure medium being fed to sealing elements between shaft and seal housing for the purpose of unilateral sealing, characterised in that the sealing elements form a known annular gap (10) for the exit of the pressure medium and the outlet-side region of the annular gap is directed against the medium to be sealed.

2. Seal according to Claim 1, characterised in that the annular gap forms a ring nozzle.

3. Seal according to Claims 1 and 2, characterised in that at least one ring nozzle wall is composed of elastic material.

4. Seal in according to Claims 1 to 3, characterised in that at least one ring nozzle wall as a sealing sleeve with sealing edges abuts the shaft when the ring nozzle is pressureless or virtually pressureless.

5. Seal in according to Claims 1 to 4, characterised in that several ring nozzles are formed by several sealing rings (9) arranged one behind the other.

GEORG HANSMANN VDI
PATENTS ENGINEER

P.3886

Applicant: Howaldtswerke-Deutsche Werft Aktiengesellschaft Hamburg und Kiel, 23 Kiel 14, Schwentinestrasse

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Seal for rotating shafts

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1)The invention relates to a seal for rotating shafts, in particular stern tube seal for marine screw propellers, a pressure medium being fed to sealing elements between shaft and seal housing for the purpose of unilateral sealing.

2)Known lip seals are passive components formed variously and dependent upon contact pressure, require lubrication and are made of elastic materials. Known lip seals are for the most part only suitable for sealing pressureless fluids. For these seals it is advantageous if at least the fluid located on one side of the seal, and where possible on the side with the greater pressure, is a lubricating fluid. Then a lubricating film can form between the sealing lip and the rotating sliding partner, which reduces the wear on the sliding partner respectively the renewal intervals. This is particularly the case if the sealing lip contact pressure can be matched to the pressure of the fluids to be sealed as well as to the sliding speeds.

3)Further, pressure control and compensation apparatus for the annular chambers between sealing rings arranged one behind the other as well as lubricating apparatus which operate periodically are known. Despite their cost this apparatus has not produced satisfactory operating results, respectively if there is lubrication, the lubricant escapes into the fluid to be sealed,

respectively into the seawater in the case of stern tube seals, which can lead to environmental pollution.

4)A seal is also known which comprises sealing lips between which a pressure gas respectively a pressure fluid is guided. Finally, guiding an oil under static pressure between two sealing elements is known.

5)The object of the seal as per invention is to avoid the known defects and in the case of relatively large ships in particular to also permit reliable and environmentally-friendly sealing of the stern nut against penetrating sea water, to largely avoid contact of the sliding partners and to reduce wear without the use of lubricating oil.

6)The object is achieved in that the sealing elements form a known annular gap for the exit of the pressure medium and the outlet-side region of the annual gap is directed against the medium to be sealed. The annular gap may take the form of a ring nozzle.

7)At least one ring nozzle wall may be made of elastic material. For emergency operation if the ring nozzle is pressureless or virtually pressureless at least one ring nozzle wall as sealing sleeve with sealing edge can abut the shaft. Finally, several sealing rings arranged one behind the other can form several ring nozzles. The seal using nozzles is a seal with active action. For this the seal has two or more lips which form the outlet edges of nozzles.

8)The nozzle profiles directed against the medium to be sealed are fed from the annular chambers formed by the seal housing, which annular chambers for their part are supplied with motive water respectively motive fluid by pumping apparatus.

9)The pressure and quantity of the motive water causes the elastic sealing lips to lift from the rotating shaft until the freeing of the cross-section required for the quantity of motive water. The direction of the motive water leaving the nozzles at high speed determines the direction of flow of the fluid located beneath the sealing lips. If the pumping capacity if set correctly not only is the sealing lip facing the fluid to be sealed raised, but also the rear-side sealing lip through suction as in the case of a jet pump. In doing so,

a) the sealing lips are raised fully from the shaft and so any wear is avoided

and

b) fluid respectively air between sealing lip and shaft and from the space behind the rear-side sealing lip is conveyed to the side of the fluid to be sealed.

10)Three exemplified embodiments of the seal are shown in longitudinal section in the drawing.

11)Fig. 1 shows the shaft 1 with a bush 2 moving with the shaft and the seal housing 3 with the clamping ring 4. A pressure medium pipe 5 runs through an annular chamber 14 between two circularly arranged sealing lips 6, 7, which can be connected with one another by webs 15 and which with their sealing edges 8 abut the bush 2 and run at an incline towards the fluid to be sealed.

12)The sealing lips 6 and 7 may be made of rigid or elastic material. Between them they form an annular gap 10 respectively a ring nozzle 11 (Fig.2). Several elastic sealing rings 9 arranged one behind the other are shown in Fig.2 . They form several ring nozzles 11.

13)An elastic sealing lip ring 12 and a rigid ring 13 are shown as a seal in Fig. 3.

14)It is understood from the description that the seal cannot protect a lubricating oil chamber from the penetration of seawater for example. Therefore, and expediently an open air space or a ventilated space filled with an environmentally-friendly sealing liquid is arranged opposing the fluid to be sealed.

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[Translator's note: original page shows diagram with numbers but no text]

HDW patent comments in comparison with JW TBMS:

1) Seal is designed for marine stern tube arrangements (paragraph 1).
2) Key aspect of advantage of design is to improve reliability of stern tube seal arrangement by preventing leakage of lubricant into sealed (seawater) fluid, thus reducing pollution (paragraphs 3, 5). JW TBMS design effectively uses a grease purge to act as barrier in pressure balance with un-sealed side in order to protect the primary seal from abrasive debris.
3) There is no detail in HDW patent of pressure differentials across multiple seal arrangements being stepped in order to cater for a greater overall differential without exposing seal to full drop.
4) Paragraphs 2 and 3 outline known principles of importance in maintaining lubricating film under seal lips on rotating shafts to minimise seal wear and optimise fluid film between dynamic parts. Seawater on marine application is not ideal; HDW patent seal relies on primary seal lip being lifted from shaft by water injection (paragraph 9a) in order to reduce seal wear, as sealed fluid is seawater.
5) The water injection, and flow rate out in to the sealed fluid (seawater) is stated to cause the air on the sealed side of the arrangement to be conveyed out to the sealed fluid (seawater) side. This would suggest that the flow is such that a 'venturi' effect is set up (paragraph 9b).
6) The grease injection into the annular void between the primary seal and the shield is not intended in any way to lift the lip of the primary seal from the shaft.

R Clifford
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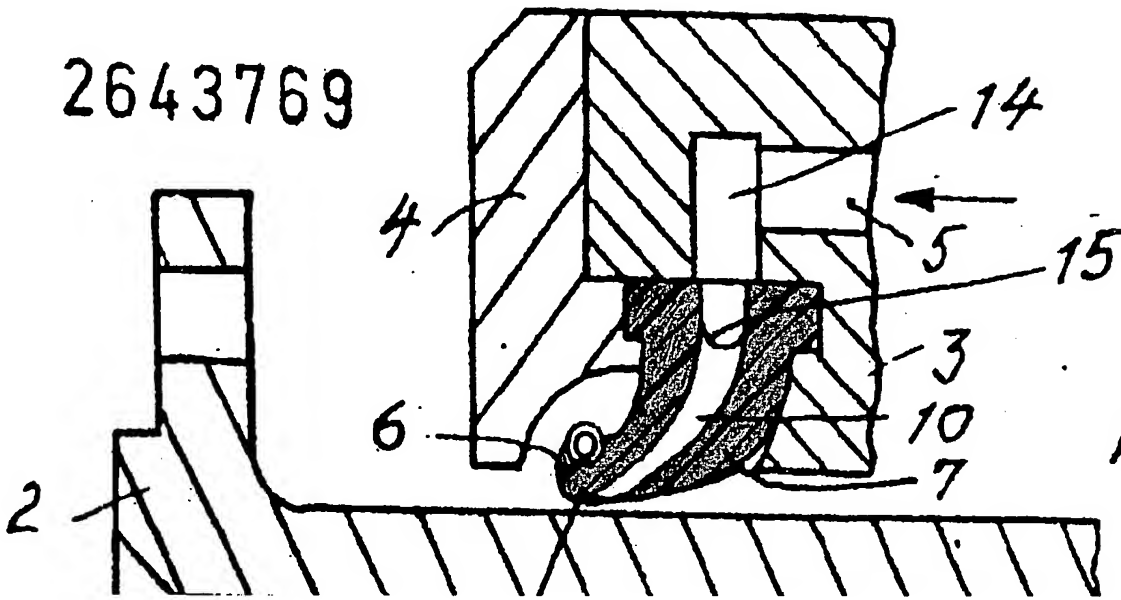

FIG. 1